

Form INV-2 EMISSION POINT DESCRIPTION

Duplicate this form for EACH
Emission POINT

1) Company/Facility Name	ACME CORPORATION		1a) Form INV-2 Page	2	of	3
2) Emission Point Number	EP2					
3) Emission Point Description	SPRAY PAINT BOOTH STACK					
4) Is this stack/vent used as an Emergency Bypass Stack?	No	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>		
If YES, for which stack(s)? List Emission Point Nos.:						
EMISSION POINT INFORMATION						
5) Emission Point Type						
Stack/Vent	<input checked="" type="checkbox"/>					
Fugitive (specify)	<input type="checkbox"/>					
Other (specify)	<input type="checkbox"/>					
6) Stack Shape and Dimensions: (interior dimensions at exit point)						
Circular Diameter:	<input checked="" type="checkbox"/>	30	inches			
Rectangular Dimensions:	<input type="checkbox"/>		inches	X		inches
Other Dimensions	<input type="checkbox"/>		inches			
7) Stack Height Above Ground	18	feet				
8) Does the Emission Point have a rain cap (or anything else) which obstructs the flow of gases leaving the Emission Point, or a horizontal discharge?						
No	<input type="checkbox"/>	YES (specify):	<input checked="" type="checkbox"/>	RAIN CAP		
9) COMPOSITION OF EXHAUST STREAM						
Exhaust Stream Characteristics	Emission Point Composition of Exhaust Stream		Units of Measure			
a) Flow Rate	18,000		<input checked="" type="checkbox"/> ACFM <input type="checkbox"/> SCFM			
b) Temperature	ambient		Degree Fahrenheit			
10) BYPASS STACKS						
Bypass Stack – Emission Point No.		Bypass Stack Description				
Bypass Stack – Emission Point No.		Bypass Stack Description				
11) LIST OF EMISSION UNITS VENTING THROUGH THIS EMISSION POINT						
Emission Unit No.	Emission Unit No.	Emission Unit No.	Emission Unit No.			
EU2						

Duplicate this form as needed

TYPE ALL INFORMATION

(DNR Form 542-4004. December 24, 2007)

Form INV-5 CALCULATIONS

Duplicate this form for each Form it will
accompany in the Questionnaire

1) Company/Facility Name	ACME CORPORATION			1a) Form INV-5 Page	2	of	5
2) Emission Point No.	EP2	3)	Emission Unit No.	EU2			
4) Calculations are provided in support of information reported on Form INV -		3 <input checked="" type="checkbox"/>	4 <input type="checkbox"/>	for the Emission Point and Emission Unit listed above.			
5) Emissions Calculations							

ACME Corporation applies a base coat and a top coat to each wagon in the same spray booth. The paint comes in five gallon pails and is sprayed directly from the container with no thinning or mixing at the facility. The paint booth has an Iowa Air Quality construction permit with a paint usage limit of 4,000 gallons per year. ACME Corp only sprayed 1,300 gallons per year (500 gallons of basecoat and 800 gallons of top coat). ACME Corp. uses a high volume low pressure (HVLP) spray gun with a maximum capacity of 7 gallons/hr. The filter used in the booth has a 95 percent particulate removal efficiency.

Material balance (also known as mass balance) utilizes the raw material usage rate to estimate the amount of pollutant emitted. In this method, emissions are estimated as the difference between material input and material output across a process. This method is typically used in surface coating processes. Information regarding the amount of pollutants in a material can be found on the material safety and data sheet (MSDS).

Most material balances assume that all solvent used in a process will evaporate to become air emissions somewhere at the facility. In these cases, emissions equal the amount of solvent contained in the surface coating.

From information found on paint MSDS the top and base coats have the following characteristics and HAP components:
(ref HAP/HAP list)

	Top Coat	Base Coat
Paint Weight (lbs/gal)	8.75	7.21
% VOC	25	42
% Solids	75	58
% Xylene	8	2
% Toluene	0	15

Note: All percents are weight percents and expressed as percent of total paint weight

POTENTIAL EMISSIONS:

Step 1 - Determine the maximum amount of paint that could be used

Since ACME Corp. has a usage limit of **4,000** gallons per year, this is the maximum amount of paint that could be used. If they didn't have this limit, the maximum usage would be calculated by taking the maximum gun capacity (7 gallon/hr), and multiplying by 8,760 hours per year.

$$(7 \text{ gallon/hr}) \times (8,760 \text{ hrs/yr}) = 61,320 \text{ gallons/yr}$$

Step 2 - Calculate the yearly potential VOC and HAP emissions

To calculate the maximum amount of VOC and HAP emitted from this spray booth in one year, the highest amounts of each constituent from the base or top coat must be used.

In this case the top coat VOC = $0.25 \times 8.75 \text{ lbs/gal} = 2.19 \text{ lbs VOC/gal}$.

The base coat VOC = $0.42 \times 7.21 \text{ lbs/gal} = 3.03 \text{ lbs VOC/gal}$, which is the higher VOC content.

First, multiply the greatest VOC density (base coat 3.03 lbs/gal) by the maximum paint used (4,000 gallons). To convert it to tons per year divide the answer by 2,000 lbs/ton.

$$(\text{Density lbs/gal}) \times (\text{Max. annual paint usage gal/yr}) \times (1 \text{ ton}/2,000 \text{ lb}) = 3.03 \text{ lbs/gal} \times 4,000 \text{ gal/yr} \times 1 \text{ ton}/2,000 \text{ lbs} = 6.06 \text{ tons/yr}$$

Form INV-5 CALCULATIONS

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1) Company/Facility Name	ACME CORPORATION			1a) Form INV-5 Page	3	of	5
2) Emission Point No.	EP2	3)	Emission Unit No.	EU2			
4) Calculations are provided in support of information reported on Form INV -		3	<input checked="" type="checkbox"/>	4	<input type="checkbox"/>	for the Emission Point and Emission Unit listed above.	
5) Emissions Calculations							

POTENTIAL EMISSIONS (CONTINUED)

To calculate the maximum emissions of each HAP, use the same formula, but in each case use the paint with the highest density of the HAP.

$$\text{Xylene} = (8.75 \text{ lb/gal}) \times (4,000 \text{ gallon/yr}) \times (0.08) \times (1 \text{ ton}/2,000 \text{ lbs}) = \mathbf{1.40 \text{ tons/yr}}$$

$$\text{Toluene} = (7.21 \text{ lb/gal}) \times (4,000 \text{ gallon/yr}) \times (0.15) \times (1 \text{ ton}/2,000 \text{ lbs}) = \mathbf{2.16 \text{ tons/yr}}$$

Step 3 - Calculate the yearly potential PM_{2.5} and PM₁₀ emissions. For surface coating, PM_{2.5} and PM₁₀ are assumed to be equal.

To calculate PM_{2.5} and PM₁₀ emissions the spray transfer efficiency (TE) of the spray gun and the control efficiency (CE) of the filter must be inserted in the formula used to calculate the VOC and HAP emissions. The transfer efficiency is the percentage of paint from the gun that actually adheres to the part being painted. The HVLP gun has a transfer efficiency of 65%, and the filter control efficiency is 95%. Refer to Appendices C and D or other supporting documentation for guidance on transfer and control efficiencies.

In ACME Corp.'s painting process 65% of the paint being sprayed hits the part and the remaining (35%) goes in the exhaust stream. The filters capture 95% of the solids in the exhaust and the remaining (5%) is discharged out the stack.

$$(\text{Density lb/gal}) \times (\text{Max. annual paint usage gal/yr}) \times (\text{Max. \% solid}) \times (1-\text{TE}) \times (1-\text{CE}) \times (1 \text{ ton}/2000 \text{ lbs})$$

$$(8.75 \text{ lb/gal}) \times (4,000 \text{ gal/yr}) \times (0.75) \times (1-0.65) \times (1-0.95) \times (1 \text{ ton}/2,000 \text{ lbs}) = \mathbf{0.23 \text{ tons/yr}}$$

Step 4 - Calculating maximum hourly emissions

To calculate maximum hourly emissions multiply the maximum gun capacity by the weight of the highest constituent, considering all paints used. The lb/gal density for each paint, multiplied by the percent of the pollutant in each paint equals a pound per gallon emission factor. To calculate the hourly PM₁₀ emissions the transfer efficiency and filter control efficiency must be included in the formula.

$$(\text{Max. Gun Capacity gal/hr}) \times (\text{Density lbs/gal} \times \text{Max. \% VOC/HAP}) = \text{VOC or HAP}$$

$$(\text{Max. Gun Capacity gal/hr}) \times (\text{Density lbs/gal} \times \text{Max. \% solids}) \times (1-\text{TE}) \times (1-\text{CE}) = \text{PM}_{10}$$

$$\text{VOC s} = (7 \text{ gal/hr}) \times (7.21 \text{ lb/gal} \times 0.42) = \mathbf{21.20 \text{ lb/hr}}$$

$$\text{Xylene} = (7 \text{ gal/hr}) \times (8.75 \text{ lb/gal} \times 0.08) = \mathbf{4.9 \text{ lb/hr}}$$

$$\text{Toluene} = (7 \text{ gal/hr}) \times (7.21 \text{ lb/gal} \times 0.15) = \mathbf{7.57 \text{ lb/hr}}$$

$$\text{PM}_{2.5} = (7 \text{ gal/hr}) \times (8.75 \text{ lb/gal} \times 0.75) = 45.94 \text{ lb/hr uncontrolled} \times (1-0.65) \times (1-0.95) = \mathbf{0.80 \text{ lb/hr controlled}}$$

$$\text{PM}_{10} = (7 \text{ gal/hr}) \times (8.75 \text{ lb/gal} \times 0.75) = 45.94 \text{ lb/hr uncontrolled} \times (1-0.65) \times (1-0.95) = \mathbf{0.80 \text{ lb/hr controlled}}$$

Step 5 – Calculate the emission factor

To determine the emission factor to report in Box 15, divide the lb/hr uncontrolled potential emissions by the gallons/hr capacity.

$$(\text{lb/hr emissions uncontrolled}) \times (\text{hr/gallons}) = \text{lb/gal}$$

$$\text{VOC s} = (21.20 \text{ lb/hr}) \times (\text{hr}/7 \text{ gal}) = 3.03 \text{ lb/gal}$$

$$\text{Xylene} = (4.9 \text{ lb/hr}) \times (\text{hr}/7 \text{ gal}) = 0.7 \text{ lb/gal}$$

$$\text{Toluene} = (7.57 \text{ lb/hr}) \times (\text{hr}/7 \text{ gal}) = 1.08 \text{ lb/gal}$$

$$\text{PM}_{2.5} = (45.94 \text{ lb/hr}) \times (\text{hr}/7 \text{ gal}) = 6.56 \text{ lb/gal}$$

$$\text{PM}_{10} = (45.94 \text{ lb/hr}) \times (\text{hr}/7 \text{ gal}) = 6.56 \text{ lb/gal}$$

Form INV-5 CALCULATIONS

Duplicate this form for each Form it will
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1) Company/Facility Name	ACME CORPORATION			1a) Form INV-5 Page	4	of	5
2) Emission Point No.	EP2	3)	Emission Unit No.	EU2			
4) Calculations are provided in support of information reported on Form INV -		3 <input type="checkbox"/>	4 <input checked="" type="checkbox"/>	for the Emission Point and Emission Unit listed above.			
5) Emissions Calculations							

ANNUAL ACTUAL EMISSIONS:**Step 6 - Calculating annual actual VOC and HAP emissions**

To calculate annual VOC and HAP emissions you must calculate the emissions from each coating then add them together.

(Paint used gal/yr) \times (Paint Weight lb/gal \times Pollutant %) \times (1 ton/2,000 lbs)VOC - Top Coat: (800 gal) \times (8.75 lb/gal \times 0.25) = 1,750 lb \times (1 ton/2,000 lbs) = 0.875 tonsVOC - Base Coat: (500 gal) \times (7.21 lb/gal \times 0.42) = 1,514 lb \times (1 ton/2,000 lbs) = 0.75 tons

+

1.63 tons of VOCXylene - Top Coat: (800 gal) \times (8.75 lb/gal \times 0.08) = 560 lb \times (1 ton/2,000 lbs) = 0.28 tonsXylene -Base Coat: (500 gal) \times (7.21 lb/gal \times 0.02) = 72.1 lb \times (1 ton/2,000 lbs) = 0.04 tons

+

0.32 tons of XyleneToluene -Top Coat: (800 gal) \times (8.75 lb/gal \times 0.00) = 0.00 lb \times (1 ton/2,000 lbs) = 0.0 tonsToluene -Base Coat: (500 gal) \times (7.21 lb/gal \times 0.15) = 540.75 lb \times (1 ton/2,000 lbs) = 0.27 tons

+

0.27 tons of Toluene**Step 7 - Calculating yearly PM_{2.5} and PM₁₀ emissions**To calculate the yearly PM_{2.5} and PM₁₀ emissions, the same formula is used, but transfer efficiency and control efficiency must be taken into account.Top Coat: (800 gal) \times (8.75 lb/gal \times 0.75) \times (1-0.65) \times (1-0.95) = 91.88 lb \times (1 ton/2,000 lbs) = 0.05 tonsBase Coat: (500 gal) \times (7.21 lb/gal \times 0.58) \times (1-.65) \times (1-0.95) = 36.59 lb \times (1 ton/2,000 lbs) = 0.02 tons

+

0.07 tons of PM_{2.5} and PM₁₀

Note: This example is for a painting operation where the paint is not thinned on-site. If thinning occurs on-site this must be taken into account to determine the maximum constituents of each coating. For additional guidance on this contact the Department of Natural Resources or the Iowa Waste Reduction Center.

Step 8- Calculate the emission factor

To determine the emission factor to report in Box 15, divide the total tons emissions by the gallons used and convert tons to pounds.

[(tons) / (gallons)] \times (2,000 lbs/ton) = lb/galVOC s = (1.63 tons/1,300 gallons \times 2,000 lbs/ton) = 2.51 lb/galXylene = (0.32 tons/1,300 gallons \times 2,000 lbs/ton) = 0.49 lb/galToluene = (0.27 tons/1,300 gallons \times 2,000 lbs/ton) = 0.42 lb/galPM_{2.5} = (0.07 tons/1,300 gallons \times 2,000 lbs/ton) \times (1/1-.95) \times (1-.65) = 6.15 lb/galPM₁₀ = (0.07 tons/1,300 gallons \times 2,000 lbs/ton) \times (1/1-.95) \times (1-.65) = 6.15 lb/gal

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Form INV-3 EMISSION UNIT DESCRIPTION – POTENTIAL EMISSIONS

Duplicate this form for EACH
Emission UNIT

1) Company/Facility Name	ACME CORPORATION				1a) Form INV-3 Page	2	of	3	
2) Emission Point Number	EP2								
EMISSION UNIT (PROCESS) IDENTIFICATION & DESCRIPTION									
3) Emission Unit Number	EU2								
4) SCC Number	40202501								
5) Description of Process	SPRAY PAINTING								
6) Date of Construction	8/1/1985	7) Date of Installation	8/1/1985	8) Date of Modification					
9) Raw Material – OR Fuels Used List worst case for EACH pollutant	PAINT								
10) Federally Enforceable Limit	4,000 GALLONS PER YEAR								
11) Permit or Rule Establishing Limit	CONSTRUCTION PERMIT 85-A-036								
12) Maximum Hourly Design Rate	7.0	GALLONS					Per Hour		
13) AIR POLLUTION CONTROL EQUIPMENT (CE)									
Control Equipment Number	CE1								
Control Equipment Description	PANEL FILTER								
Control Equipment Number									
Control Equipment Description									
POTENTIAL EMISSIONS									
14 Air Pollutant	15 Emission Factor	16 Emission Factor Units	17 Source of Emission Factor	18 Ash or Sulfur %	19 Potential Hourly Uncontrolled Emissions (Lbs/Hr)	20 Combined Control Efficiency	21 Transfer Efficiency	22 Potential Hourly Controlled Emissions (Lbs/Hr)	23 Potential Annual Emissions (Tons/Yr)
PM-2.5	6.56	LB/GAL	MASS BAL		45.92	95	65	0.8	0.23
PM-10	6.56	LB/GAL	MASS BAL		45.92	95	65	0.8	0.23
SO ₂									
NO _x									
VOC	3.03	LB/GAL	MASS BAL		21.21				6.06
CO									
Lead									
Ammonia									
POTENTIAL EMISSIONS – Individual HAPs and additional regulated air pollutants – list each individual pollutant name in Column 14									
Xylene	0.7	LB/GAL	MASS BAL		4.9				1.40
Toluene	1.08	LB/GAL	MASS BAL		7.56				2.16

*Sources of Emission Factors: CEM .. Stack Test .. Mass Balance .. AP-42 .. WebFIRE.. TANKS.. EPA-L&E .. Worksheet .. Other – Specify

Duplicate this form as needed

TYPE ALL INFORMATION

(DNR Form 542-4001. December 24, 2007)

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Form INV-4 EMISSION UNIT DESCRIPTION – ACTUAL EMISSIONS

Duplicate this form for EACH
Emission UNIT

1) Company/Facility Name	ACME CORPORATION			1a) Form INV-4 Page	2	of	3
2) Emission Year	2008	3) Emission Point Number	EP2				
EMISSION UNIT – ACTUAL OPERATIONS AND EMISSIONS							
4) Emission Unit Number	EU2			5) SCC Number	40202501		
6) Description of Process	SPRAY PAINT BOOTH						
ACTUAL THROUGHPUT							
7) Raw Material	PAINT						
8) Actual Throughput – Yearly Total	1,300	9)	Units Raw Material	GALLONS			
Actual Operating Rate/Schedule							
	10) Percent of Total Operating Time	11) Hours/Day		12) Days/Week		13) Weeks/Quarter	
JAN – MAR	25	8		5		13	
APR – JUN	25	8		5		13	
JUL – SEP	25	8		5		13	
OCT - DEC	25	8		5		13	
14) AIR POLLUTION CONTROL EQUIPMENT (CE)							
Control Equipment Number	CE2						
Control Equipment Description	PANEL FILTER						
Control Equipment Number							
Control Equipment Description							
ACTUAL EMISSIONS							
15 Air Pollutant	16 Emission Factor	17 Emission Factor Units	18 Source of Emission Factor	19 Ash or Sulfur %	20 Combined Control Efficiency	21 Transfer Efficiency	22 Actual Emissions (Tons/Yr)
PM-2.5	6.15	LB/GAL	MASS BAL		95	65	0.07
PM-10	6.15	LB/GAL	MASS BAL		95	65	0.07
SO ₂							
NOX							
VOC	2.51	LB/GAL	MASS BAL				1.63
CO							
Lead							
Ammonia							
ACTUAL EMISSIONS – Individual HAPs and additional regulated air pollutants – list each individual pollutant name in Column 15							
Xylene	0.49	LB/GAL	MASS BAL				0.32
Toluene	0.42	LB/GAL	MASS BAL				0.27

*Sources of Emission Factors: CEM .. Stack Test .. Mass Balance .. AP-42 .. WebFIRE.. TANKS.. EPA-L&E .. Worksheet .. Other – Specify

Duplicate this form as needed

TYPE ALL INFORMATION

(DNR Form 542-4002 December 24, 2007)

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